

# Fleet DNA Phase 1 Refinement & Phase 2 Implementation



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**National Renewable Energy Laboratory**

**2015 Annual Merit Review**

**June 11, 2015**

**Project ID: VSS160**

This presentation does not contain any proprietary, confidential, or otherwise restricted information.

# Overview

## Timeline

- **Project Start Date:** FY 2012
- **Project End Date:** FY 2017
- **Percent Complete:** ~50%

## Budget

- **Total Project Funding for FY15:** \$400K
  - DOE Share: \$400K
  - Contractor Share: Partner cost share has been in-kind support (vehicle loans, technical support, data access and data supplied to NREL) and varies by individual partner
- **Funding Received in FY14:** \$500K

## Barriers

- **Cost:** Reduce the cost associated with evaluating and developing vehicle components and configurations by providing public access to data reporting and analysis capabilities
- **Risk Aversion:** Address risk issues by providing easily accessible info to potential consumers
- **Computation models, design and simulation:** Accurate modeling efforts require real world data for successful development and validation

## Partners

Project success requires a wide range of contributing partners from industry, government, universities, and other national labs. Key past and present partners include:

- Project Lead – NREL
- ORNL – Data collection partner
- Industry – NTEA/GTA, Cummins, PG&E, Oshkosh, Parker Hannifin, Proterra
- Research – OSU, CSU, NC State, Calstart
- Gov./Reg. – SCAQMD, CARB, EPA, ANL,
- DOE programs - Clean Cities, 21<sup>st</sup> Century Truck Partnership, National Clean Fleet Partnership

# Relevance

## Project Objectives:

- Capture and quantify drive cycle and technology variation for the multitude of medium- and heavy-duty vocations
- Provide a common data storage warehouse for medium- and heavy-duty vehicle fleet data across DOE activities and labs - [www.nrel.gov/fleetdna](http://www.nrel.gov/fleetdna)
- Integrate existing DOE tools, models, and analyses to provide data-driven decision-making capabilities

**For Government:** Provide in-use data for standard drive cycle development, R&D, tech targets, and rule making

**For Original Equipment Manufacturers (OEMS):** Real-world usage datasets provide concrete examples of customer use profiles

**For Fleets:** Vocational datasets help illustrate how to maximize return on technology investments

**For Funding Agencies:** Reveal ways to optimize impact of financial incentive offers

**For Researchers:** Provides a data source for modeling and simulation

### Fleet DNA: Commercial Fleet Vehicle Operating Data

The Fleet DNA clearinghouse of commercial fleet vehicle operating data helps vehicle manufacturers and developers optimize vehicle designs and helps fleet managers choose advanced technologies for their fleets. This online tool provides data summaries and visualizations similar to real-world "genetics" for medium- and heavy-duty commercial fleet vehicles operating in a variety of vocations.

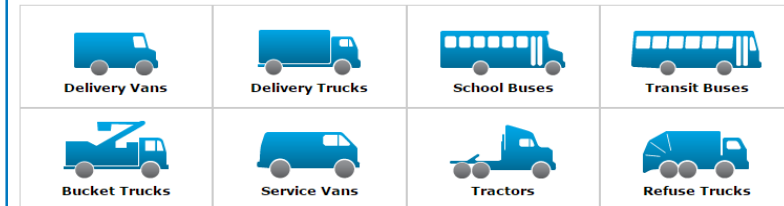
#### Contribute Data

Learn how to [contribute to Fleet DNA](#) anonymously to help other fleets analyze and improve their drive cycle metrics.

For more information, refer to the [Fleet DNA fact sheet](#).

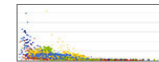
#### Data by Vehicle Category

View and download data, charts, and reports by vehicle category.



#### Composite Data for All Categories

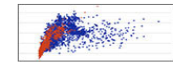
View charts with data for all the vehicle categories above or download the [composite data for all vehicles](#). Fleet DNA has 4,705 days of driving data from 486 vehicles operating in the United States.



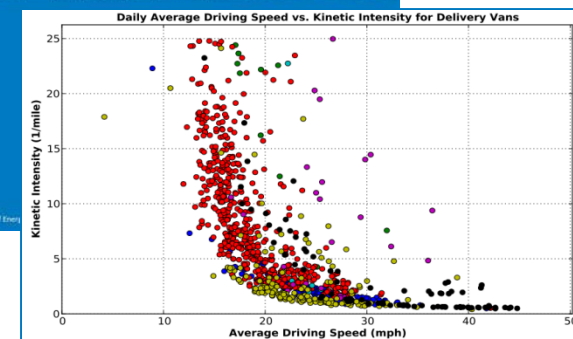
Daily Average Driving Speed and Kinetic Intensity for All Vehicle Categories



Daily Stops per Mile Distribution for All Vehicle Categories



Average Acceleration and Number of Stops for All Vehicle Categories

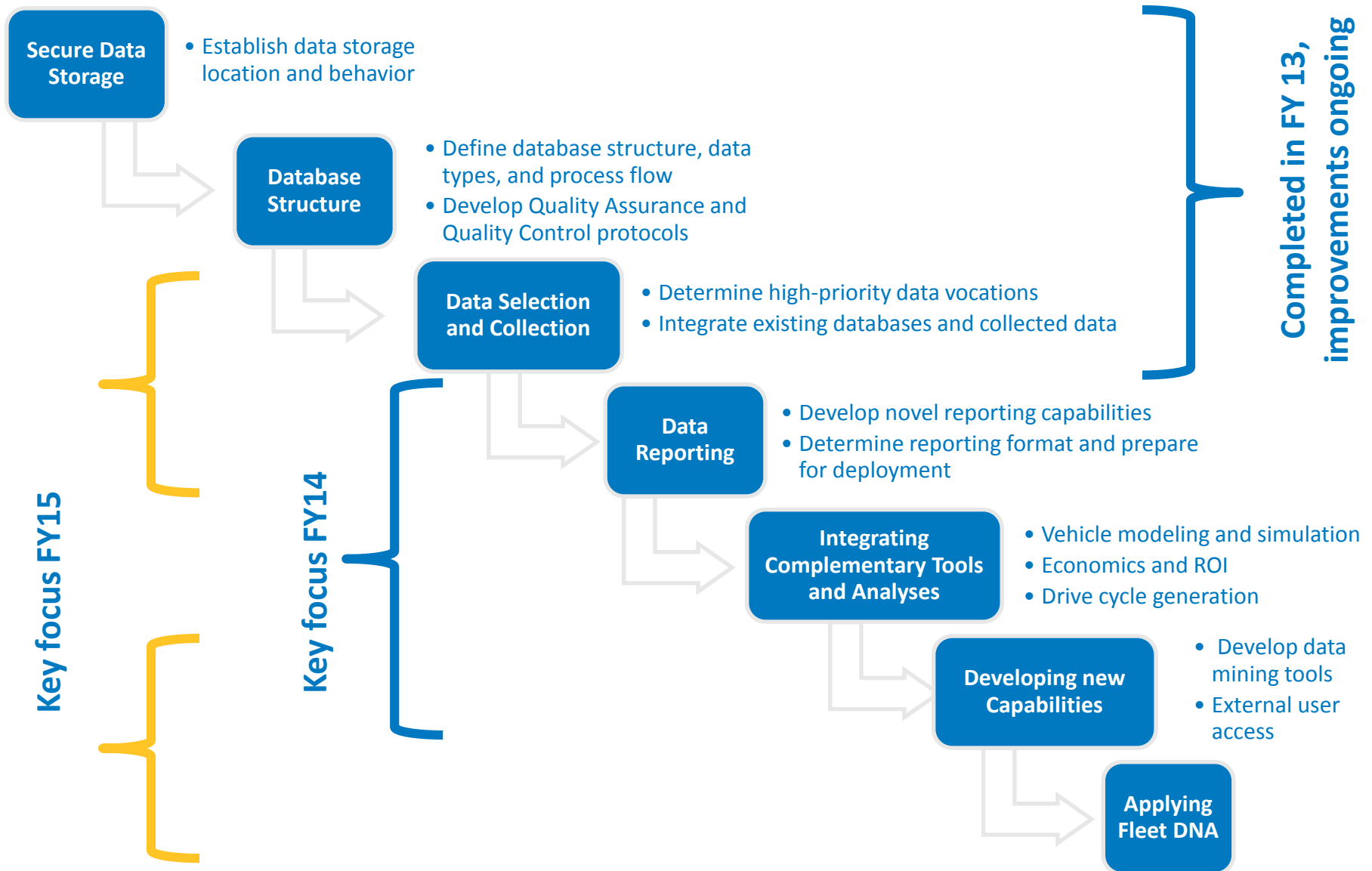


# Milestones

Month / Year	Milestone or Go/No-Go Decision	Description	Status
12/2014	Milestone report to DOE	Draft report on project status and new developments	Completed
3/2015	Milestone report to DOE	Draft report on project status and data compiled	Completed
6/2015	Milestone report to DOE	Draft report on project status and data dissemination	Pending
9/2015	Milestone report to DOE	Annual report submitted to DOE program manager	Pending

- **In addition to the above reports, additional technical project achievements planned in FY15 include:**
  - Development and publication of additional vocational data reports and results datasets
  - Continued growth of Fleet DNA database through addition of new partner data
  - Maintenance of secure database and enhancement of user accessibility
  - Forging of new industry partnerships
  - Identification of further applications of Fleet DNA data and tools
  - Ongoing integration of existing DOE tools and capabilities, and development of new ones

# Approach – Fleet DNA Development



# Approach – Secure Data Storage

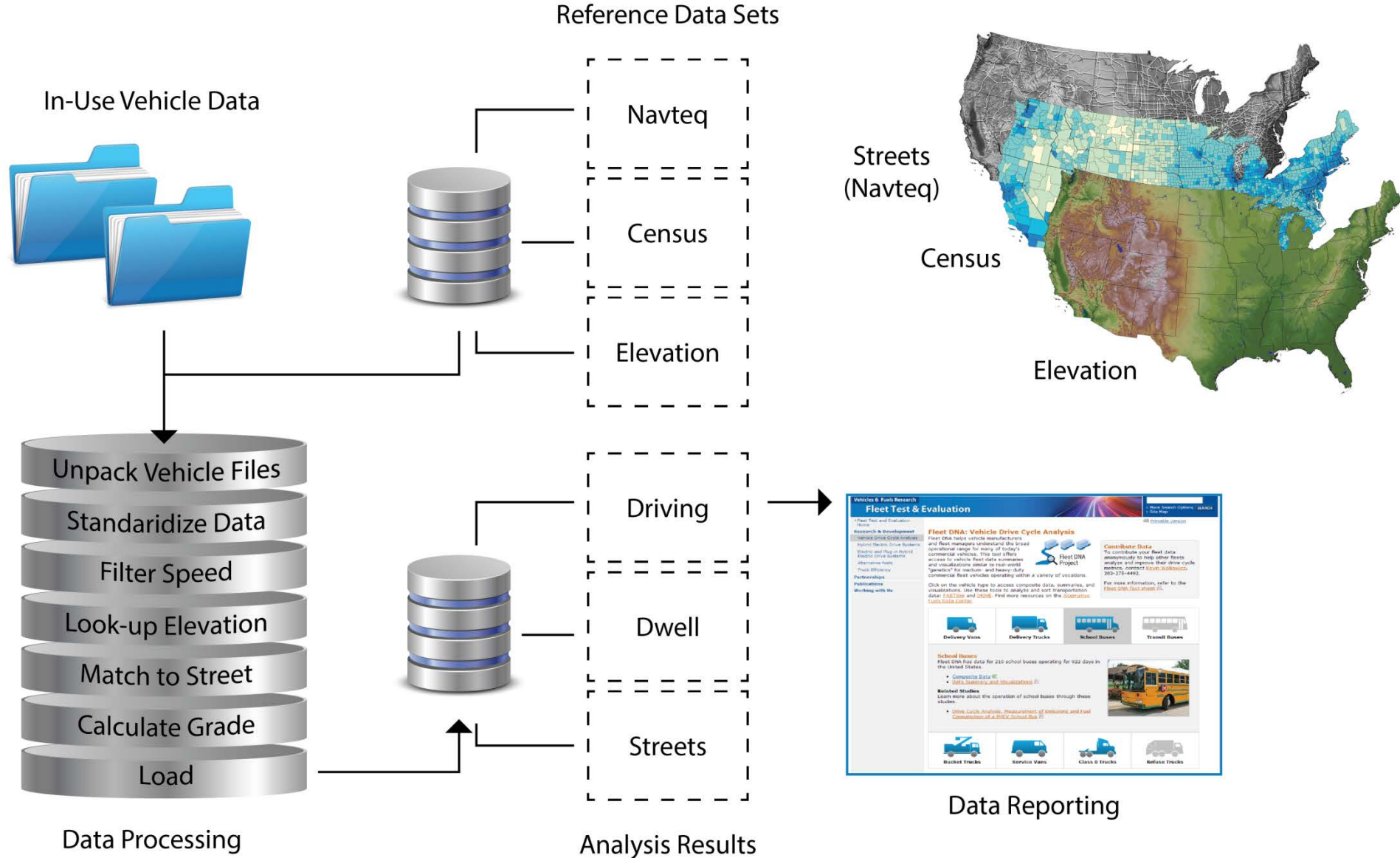
- **Data transfer/upload**
  - Data uploaded directly from ongoing Vehicle Technologies Office (VTO) data collection activities or from data partners via secure File Transfer Protocol (FTP)
- **Data protection**
  - Data stored on secure raw data handling server
  - Password Protected
    - Dual Authentication Process
  - Building badge access
  - On-site security force
  - Room key access
  - Limited to data center staff
- **Data backups**
  - Data mirrored on large storage array
  - Regular tape backup
  - Fire/disaster protection for copies



NREL Data Center  
Storage Arrays  
NREL PIX #18784

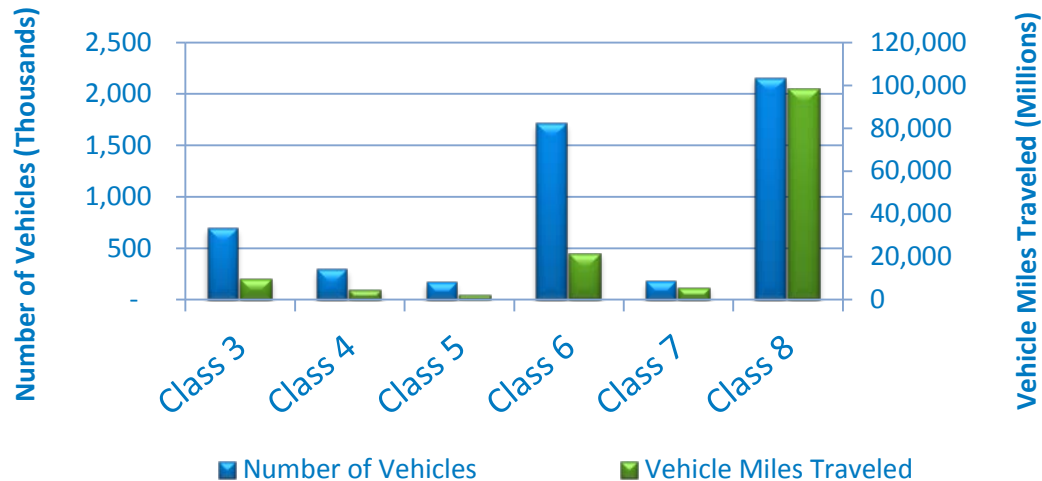


# Approach – Database Structure

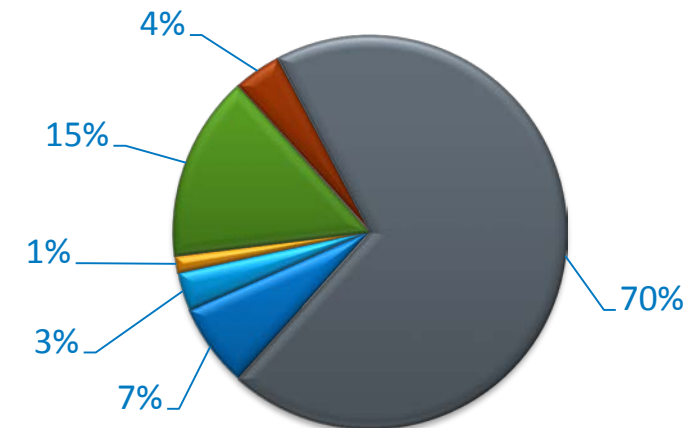


# Approach – Data Selection and Collection

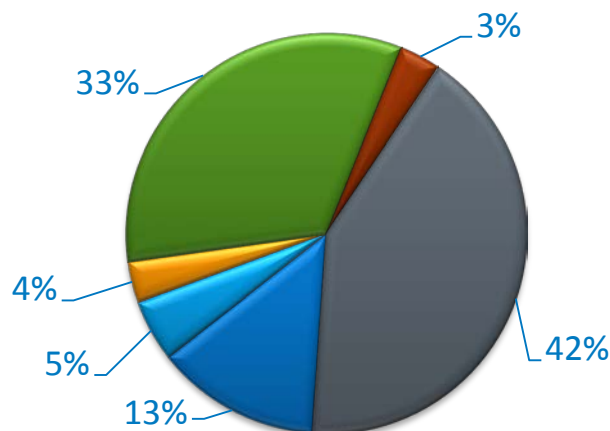
## Number of Vehicles & Miles Traveled by Class



## Vehicle Miles Traveled by Class 3-8



## Total Vehicles by Class 3-8



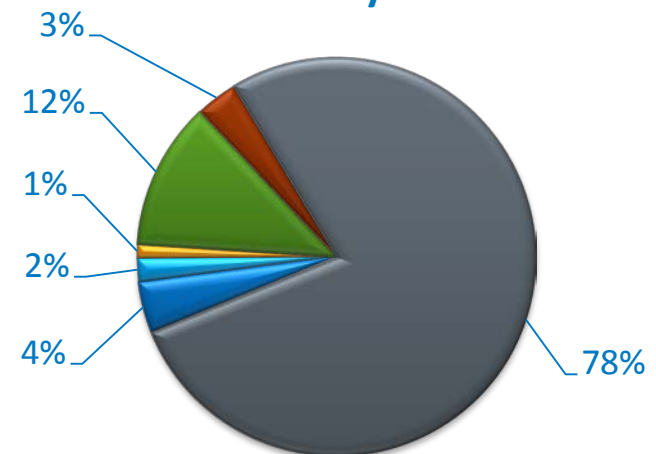
**“Class 8 trucks comprise only 41.5% of the heavy and medium truck fleet, but they account for 78% of the fuel consumed by medium and heavy trucks.”**

[http://cta.ornl.gov/vtmarketreport/pdf/2013\\_vtmarketreport\\_full\\_doc.pdf](http://cta.ornl.gov/vtmarketreport/pdf/2013_vtmarketreport_full_doc.pdf)

Data drawn from Polk Database of MD-HD vehicles and ORNL reports

■ Class 3 ■ Class 4 ■ Class 5 ■ Class 6 ■ Class 7 ■ Class 8

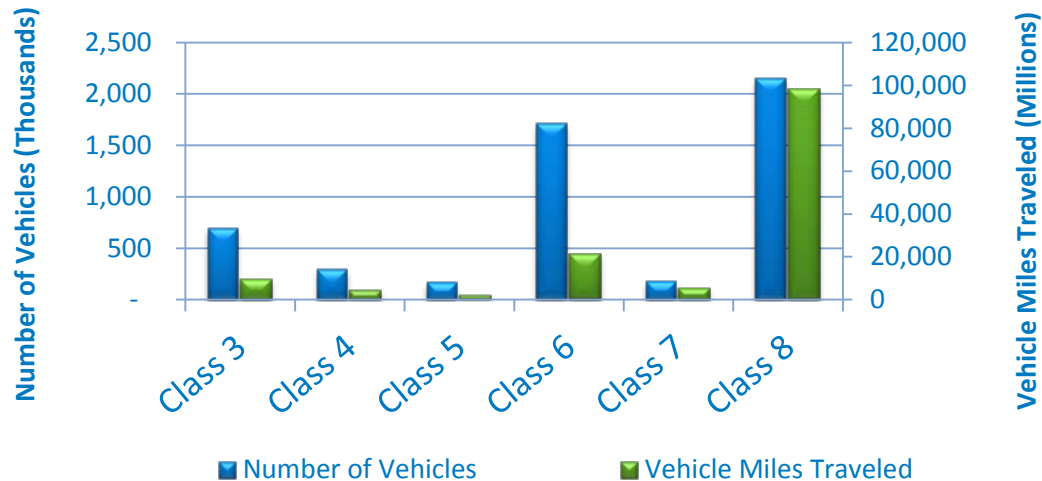
## Fuel Used by Class 3-8



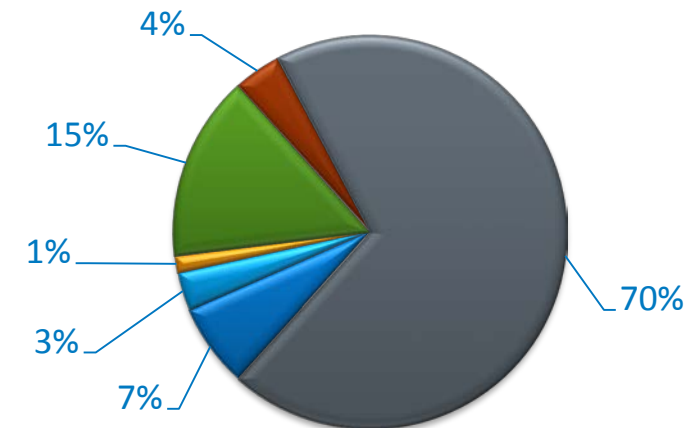


# Approach – Data Selection and Collection

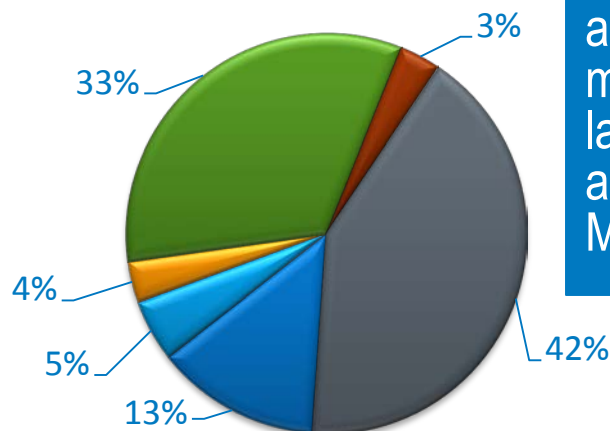
Number of Vehicles & Miles Traveled by Class



Vehicle Miles Traveled by Class 3-8

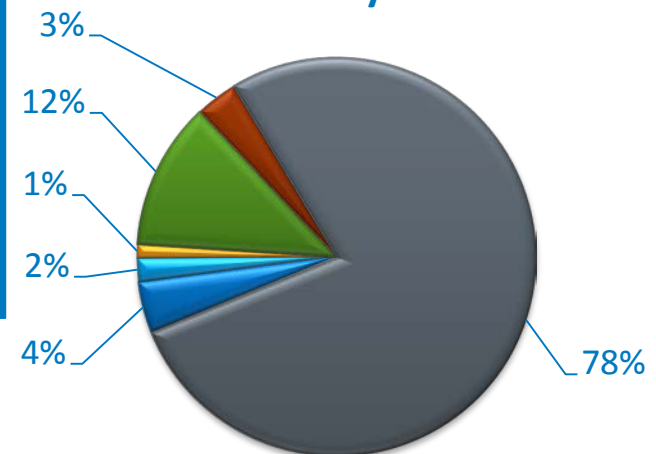


Total Vehicles by Class 3-8



Classes 3, 6, and 8 accumulate the greatest total mileage, represent the largest number of vehicles, and burn the most fuel in the MD-HD vehicle space

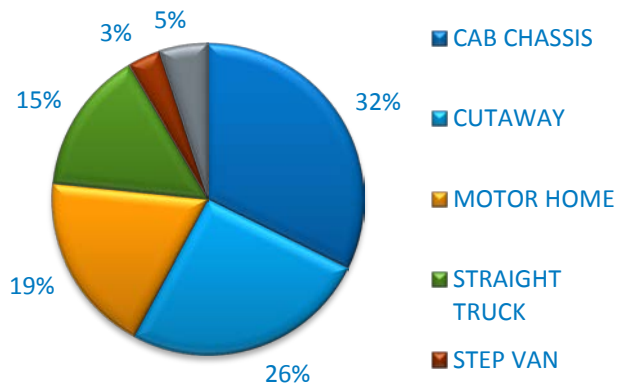
Fuel Used by Class 3-8



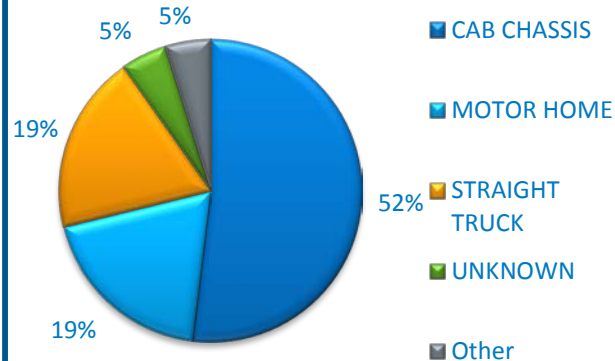
■ Class 3 ■ Class 4 ■ Class 5 ■ Class 6 ■ Class 7 ■ Class 8

# Approach – Data Collection and Selection

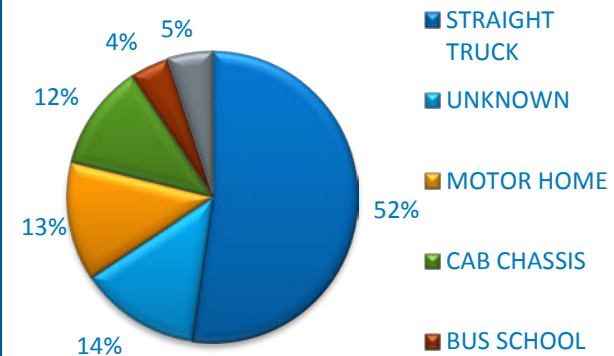
**Class 4**



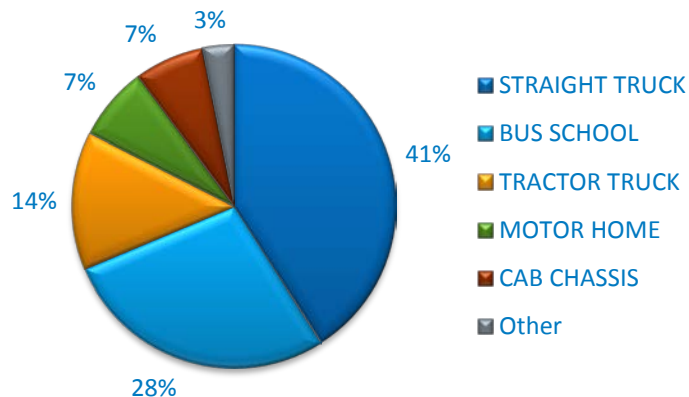
**Class 5**



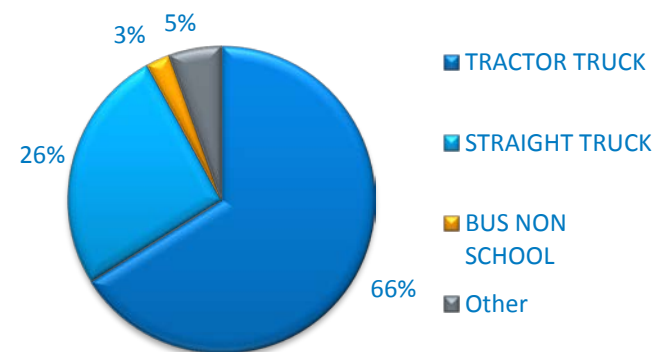
**Class 6**



**Class 7**



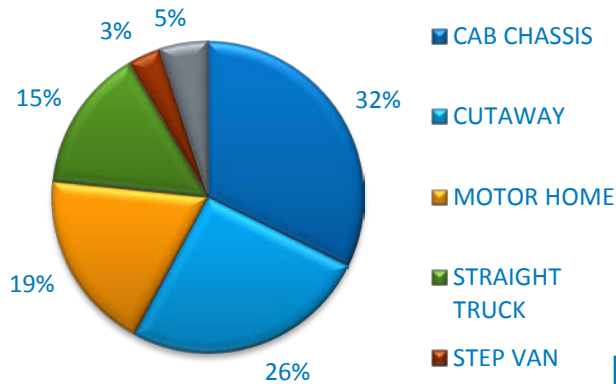
**Class 8**



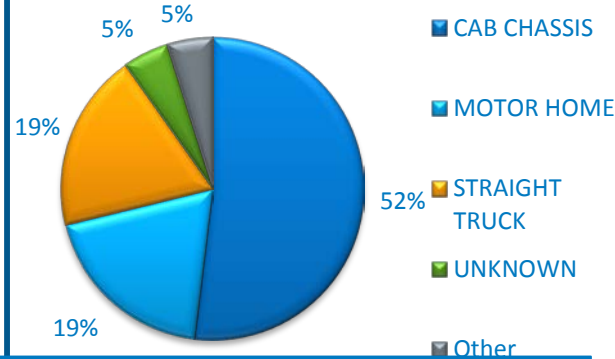
Data drawn from Polk Database of MD-HD vehicles and ORNL reports

# Approach – Data Collection and Selection

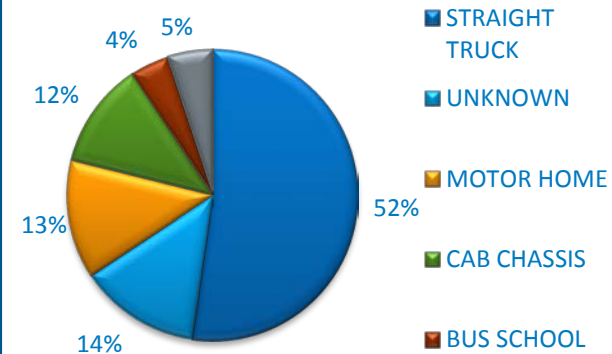
**Class 4**



**Class 5**

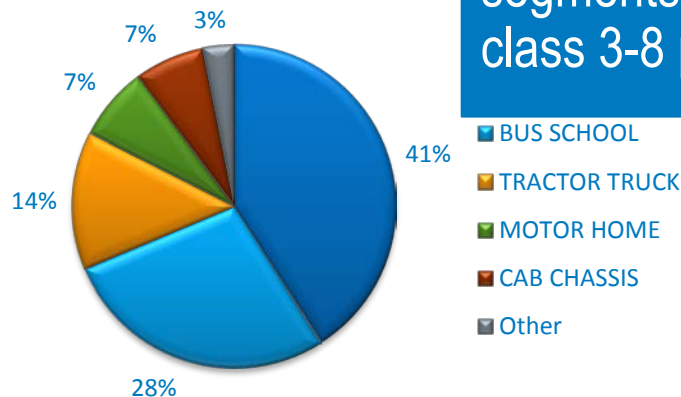


**Class 6**

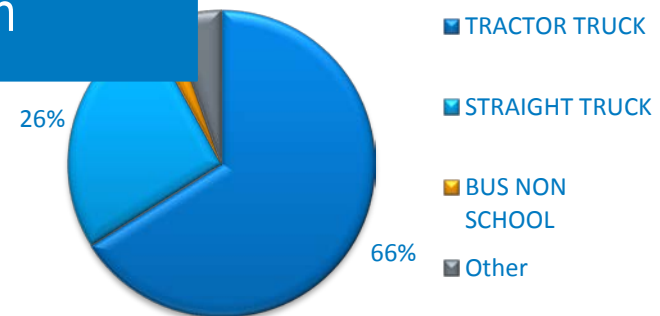


Straight trucks, cab chassis, and tractor vehicle types represent the largest segments of the overall class 3-8 population

**Class 7**



**Class 8**



Data drawn from Polk Database of MD-HD vehicles and ORNL reports

# Approach – Data Selection and Collection

- The majority of fuel usage in the medium- and heavy-duty vehicle sector occurs in class 3, 6, and 8 vehicles. Within class 3, 6, and 8, cab chassis, straight trucks, and tractor vehicle types account for the vast majority of vehicles. Ongoing data collection is therefore focused on:
  - Class 3 (Highest Priority): shuttle bus, walk-in truck, step van, utility/service truck
  - Class 6/7: transit bus, school bus, bucket truck, straight truck
  - Class 8 (Highest Priority): dump truck, concrete mixer, tow truck, fire truck, tractor trailers (beverage, tankers, bulk shipment, etc.)
- Additional focus is on enhancing the depth of data through collection of CNG/LNG/LPG fuel vehicles in addition to existing hybrid/electric/conventional datasets

**Table 5.4**  
**Truck Statistics by Gross Vehicle Weight Class, 2002**

Manufacturer's gross vehicle weight class	Number of trucks	Percentage of trucks	Average annual miles per truck	Harmonic mean fuel economy	Percentage of fuel use
1) 6,000 lbs and less	51,941,389	61.0%	11,882	17.6	42.7%
2) 6,001 – 10,000 lbs	28,041,234	32.9%	12,684	14.3	30.5%
Light truck subtotal	79,982,623	93.9%	12,163	16.2	73.2%
3) 10,001 – 14,000 lbs	691,342	0.8%	14,094	10.5	1.1%
4) 14,001 – 16,000 lbs	290,980	0.3%	15,441	8.5	0.5%
5) 16,001 – 19,500 lbs	166,472	0.2%	11,645	7.9	0.3%
6) 19,501 – 26,000 lbs	1,709,574	2.0%	12,671	7.0	3.2%
Medium truck subtotal	2,858,368	3.4%	13,237	8.0	5.2%
7) 26,001 – 33,000 lbs	179,790	0.2%	30,708	6.4	0.9%
8) 33,001 lbs and up	2,153,996	2.5%	45,739	5.7	20.7%
Heavy truck subtotal	2,333,786	2.7%	44,581	5.8	21.6%
Total	85,174,776	100.0%	13,088	13.5	100.0%

Over 90% of all medium and heavy duty fuel consumption and over 80% of total medium and heavy vehicle population

Sources: DOE Transportation Energy Data Book – 32<sup>nd</sup> Edition, and National Academy of Sciences report "Technologies and Approaches to Reducing Fuel Consumption of Medium- and Heavy- Duty Vehicles."

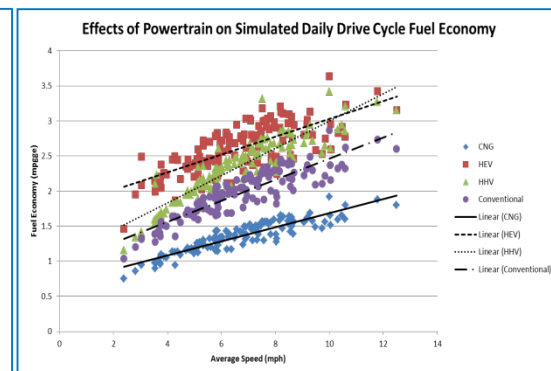
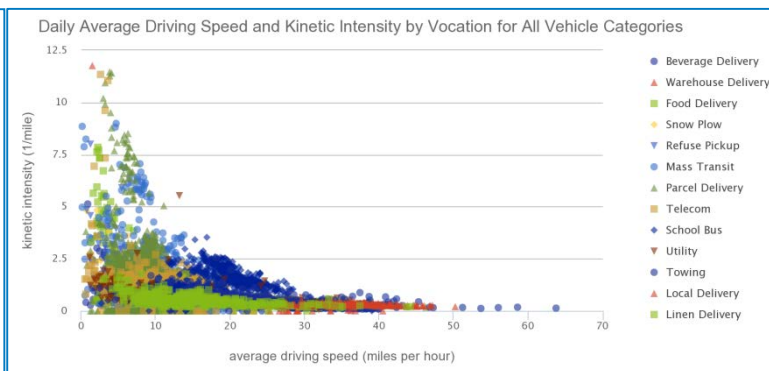
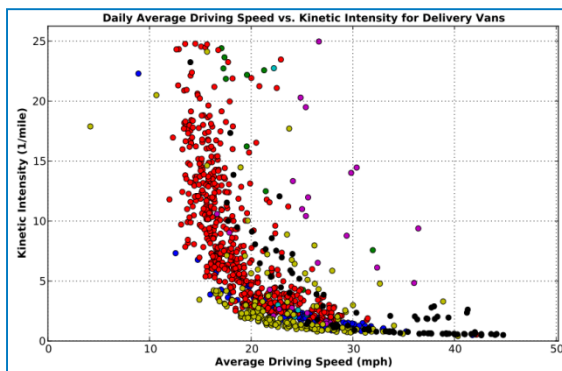
# Approach – Data Reporting

- **Multi-phase approach for public data reporting to address the interests of multiple project users/customers**
  - **Phase 1 – Static reporting website and partner specific analyses and feedback – FY13 & 14**
    - Cumulative vocational reports and source data hosted on Fleet DNA website in PDF and XLS formats
    - Provides easy access to reports and publications associated with data stored in database
    - Links to additional analysis tools and projects
    - Custom reports for project partners focusing on key areas of interest
  - **Phase 2 – Interactive data reporting – FY14 & 15**
    - Allow users to select, view, and download graphics and data
    - Insert Fleet DNA data directly into websites and reports
  - **Phase 3 – Enhance interactivity and integrated data analytics and simulation results – FY15+**
    - Link results to individual drive cycle data and supplemental vehicle information
    - Provide results of large-scale simulation and mapping of existing technology using Fleet DNA database to determine optimal cycles for specific technologies/fuels within a given vehicle vocation/type/class

## Phase 1

## Phase 2

## Phase 3



# Approach – Developing New Capabilities

The development of new capabilities within the Fleet DNA project can be categorized in three major areas:

## 1) Processing Additional Data

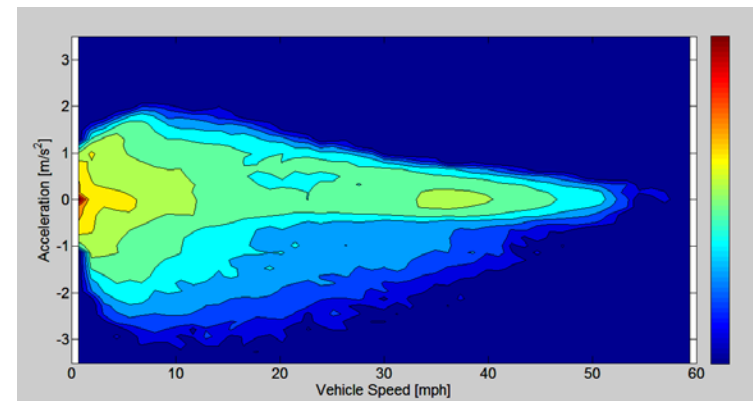
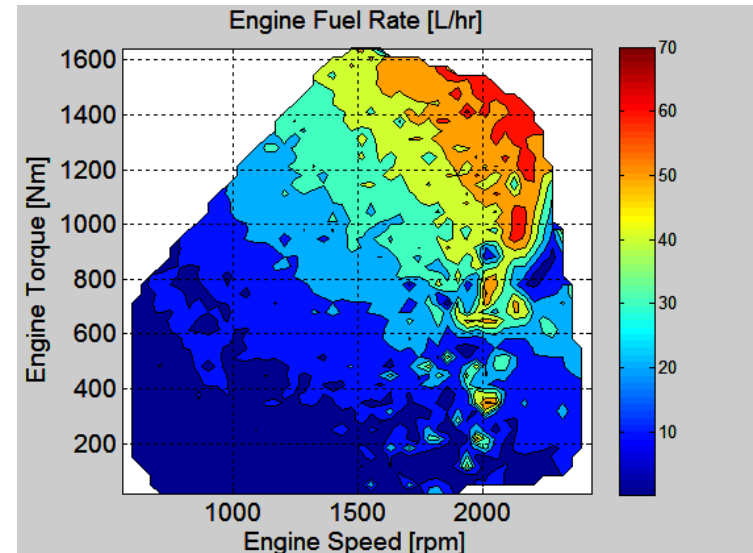
- Fueling
- Engine behavior
- Emissions
- Powertrain

## 2) Modeling and Simulation

- New vehicle models to match Fleet DNA data
- Parametric and optimization studies

## 3) Developing New Analyses

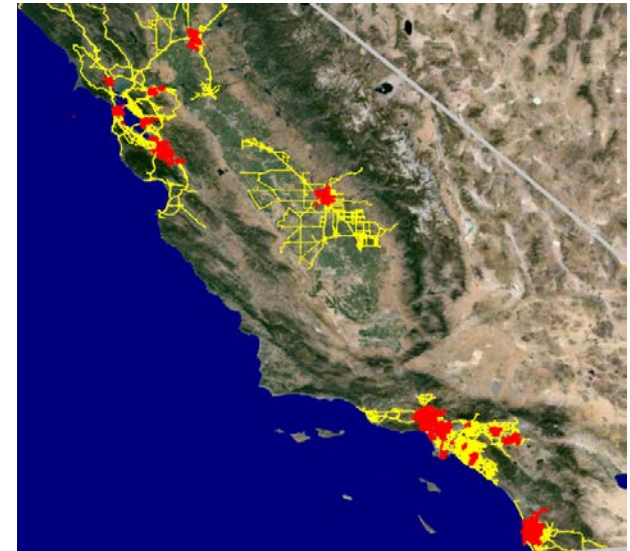
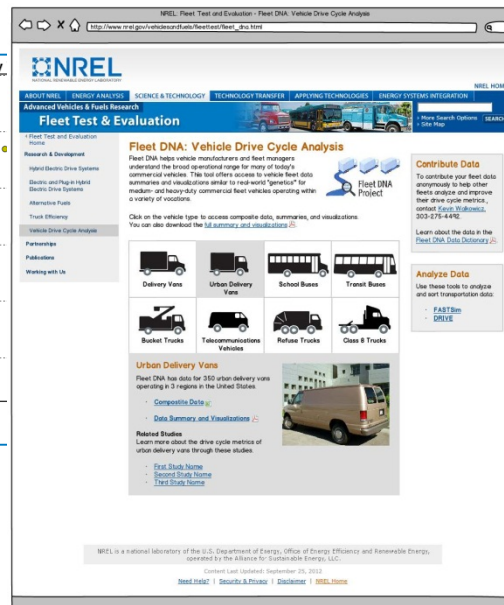
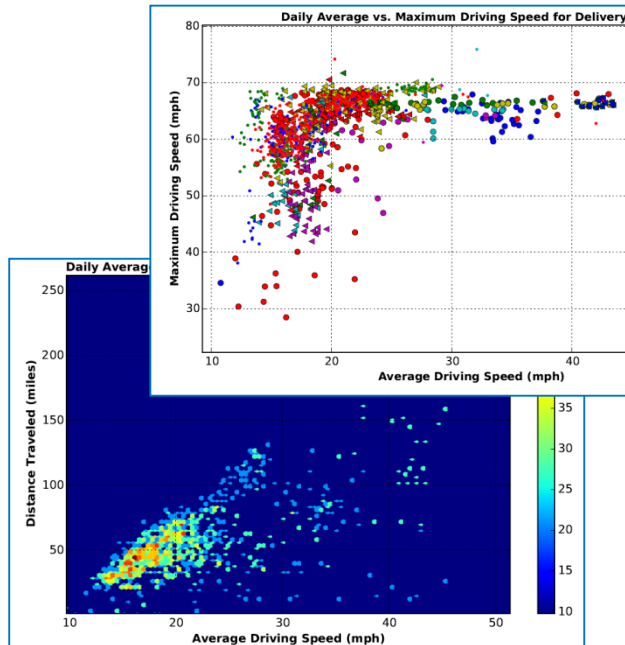
- Road grade
- Vehicle mass
- Vehicle characteristics
- Representative drive cycles













# Technical Accomplishments – FY14 Review

- Deployed Phase 1 of Fleet DNA data storage and web reporting databases
- Successful publication of 8 vocation-specific reports for major vocations of interest (delivery vans, delivery trucks, school buses, bucket trucks, service vans, and class 8 trucks)
  - 34 unique data products per report
- Fleet DNA website developed and deployed for public data report dissemination: [www.nrel.gov/fleetdna](http://www.nrel.gov/fleetdna)



# Technical Accomplishments - Data Collection

**Fleet DNA Data Summary**

		Vehicles	Vehicle Days	Distance (mi)	Deployments
	Delivery Vans	595	162,344	4,296,569	198
	Delivery Trucks	30	429	40,381	5
	School Buses	212	368	22,223	4
	Bucket Trucks	40	3,545	102,174	4
	Service Vans	14	143	3,310	2
	Class 8 trucks	191	1,496	162,804	17
	Transit Buses	20	378	48,738	6
	Refuse Trucks	43	654	34,318	7

**Fleet DNA Data Summary :**

- 198 locations (FY14 – 37 locations, over 500% YOY growth)
- 1,283 vehicles (FY14– 620 vehicles, over 200% YOY growth)
- 169,357 days (FY14 – 4,687 days, over 3600% YOY growth)
- 4,710,517 miles (FY14 – 340,875 miles, over 1300% YOY growth)
- 246 deployments (FY14 – 77 deployment, over 300% YOY growth)





NOTE: Data in table only shown for major vehicle categories currently reported on


# Technical Accomplishments – Data Reporting


[www.nrel.gov/fleetdna](http://www.nrel.gov/fleetdna)

- Successfully implemented refinements to Phase 1 static reports
  - Updated data
  - 13 new data visualizations (47 page reports)
- Deployed Phase 2 of Fleet DNA website
  - 8 unique vehicle categories
  - Interactive data charts, downloadable datasets and .pdf reports for each vehicle group
  - Links to related studies and additional resources such as DOE's Clean Cities Alternative Fuels Data Center (AFDC)

  
Delivery Vans

  
Delivery Trucks



  
School Buses


  
Transit Buses

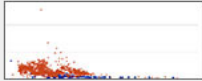
### Delivery Vans

The delivery van category includes data for walk-in and step vans ranging in size from class 3 to class 6 with primary vocations of delivering parcels, food, linens, or beverages.


Fleet DNA has 974 days of driving data from 94 delivery vans operating in the United States.

- [Composite Data](#) 
- [Data Summary and Visualizations](#) 

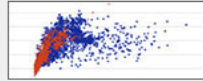




Daily Average Driving Speed and Kinetic Intensity for Delivery Vans



Daily Stops per Mile Distribution for Delivery Vans













Average Acceleration and Number of Stops for Delivery Vans

Show More Charts

### Related Studies

Learn more about the operation of delivery vans through these studies.

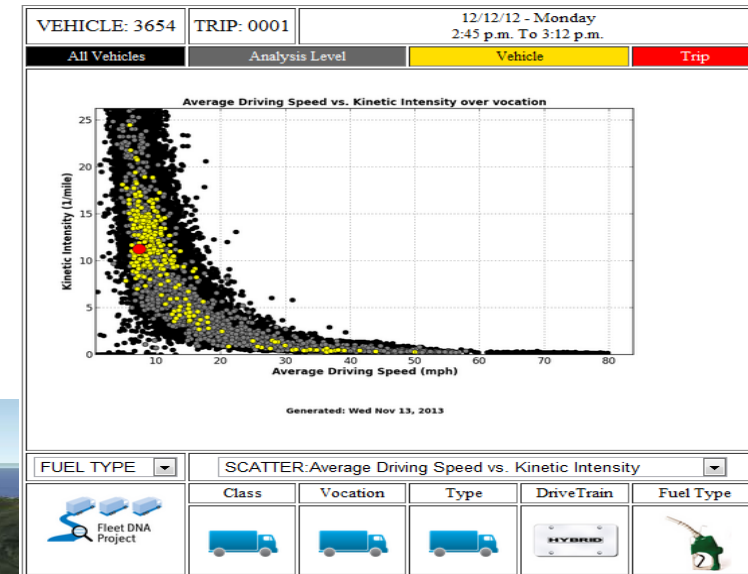
- [Hydraulic Hybrid and Conventional Parcel Delivery Vehicles' Measured Laboratory Fuel Economy on Targeted Drive Cycles](#) 
- [Project Results: Evaluating FedEx Express Hybrid-Electric Delivery Trucks](#) 
- [FedEx Express Gasoline Hybrid Electric Delivery Truck Evaluation: 12-Month Report](#) 
- [FedEx Gasoline Hybrid Electric Delivery Truck Evaluation: 6-Month Interim Report](#) 
- [Eighteen-Month Final Evaluation of UPS Second Generation Diesel Hybrid-Electric Delivery Vans](#) 
- [Measured Laboratory and In-Use Fuel Economy Observed over Targeted Drive Cycles for Comparable Hybrid and Conventional Package Delivery Vehicles](#) 
- [Thirty-Six Month Evaluation of UPS Diesel Hybrid-Electric Delivery Vans](#) 
- [Interim Project Results: United Parcel Service's Second-Generation Hybrid-Electric Delivery Vans](#) 
- [Project Overview: United Parcel Service's Second-Generation Hybrid-Electric Delivery Vans](#) 
- [United Parcel Service Evaluates Hybrid Electric Delivery Vans](#) 



# Technical Accomplishments – Developing New Capabilities

## Interactive Data Visualization

- Dynamic visualization tool allowing for the exploration of aggregate analysis results and data
  - No spatial information, and all vehicle characteristics are converted to classifications
- Currently open to the public as part of Fleet DNA Phase 2



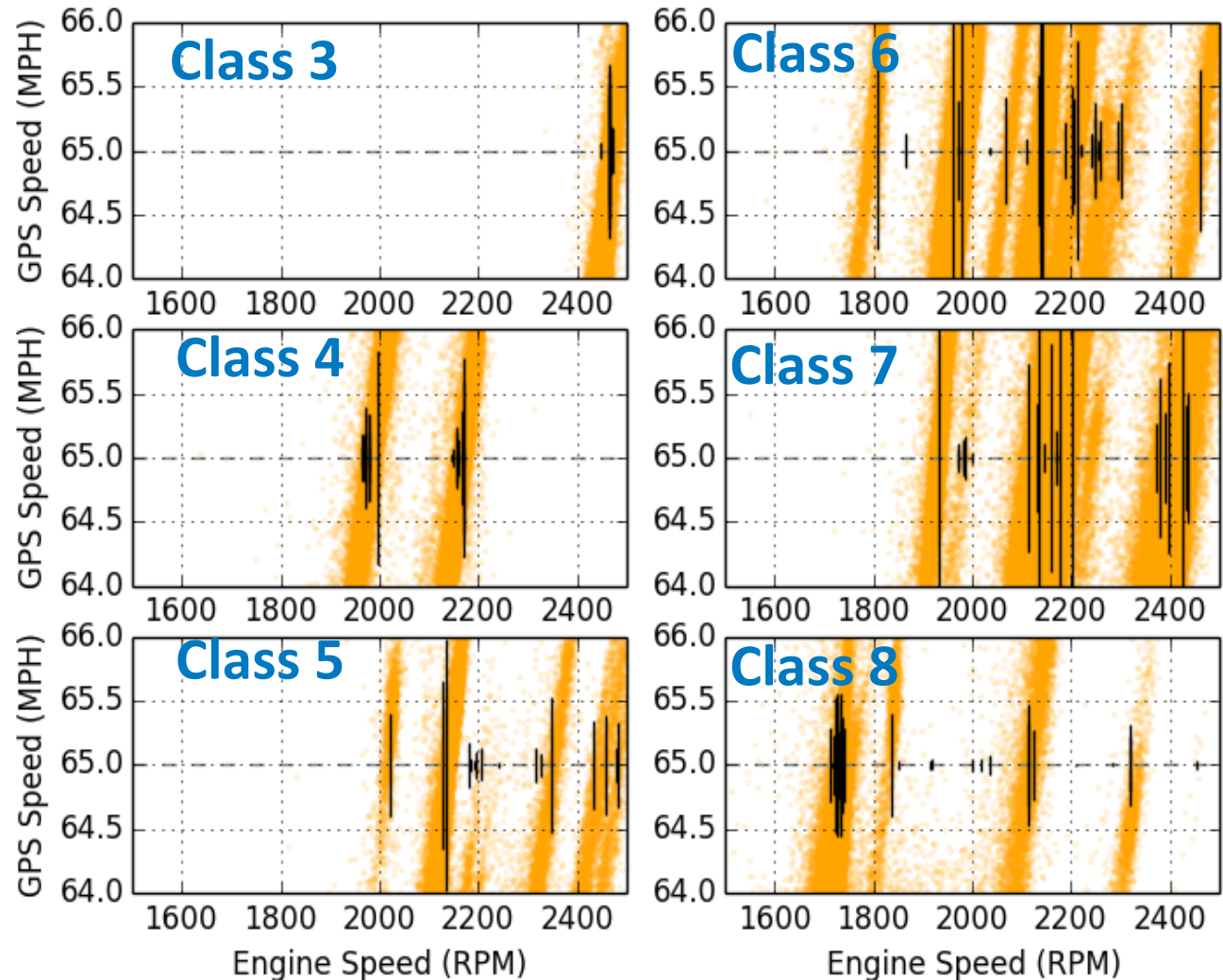
## Google Earth\High Charts Mash-up

- Non-public deliverable data product which can be shared with data partners
- Allows data providers to explore their second-by-second data
  - I.E. speed vs. road grade

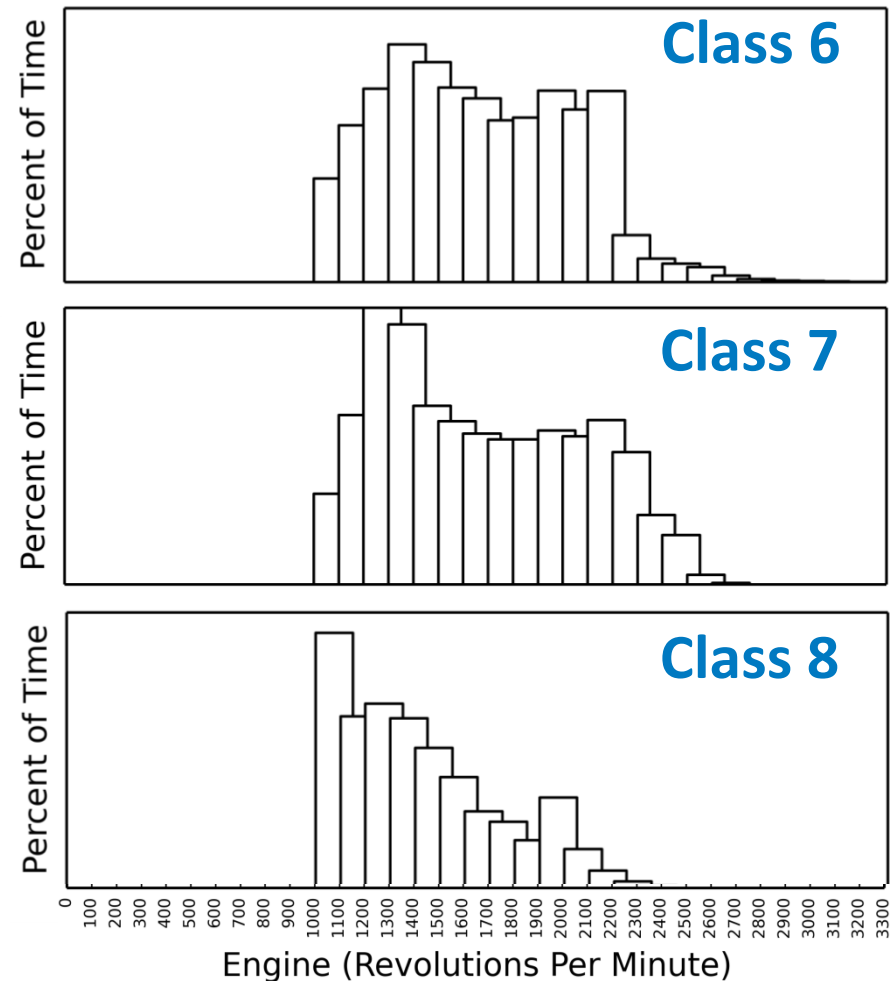
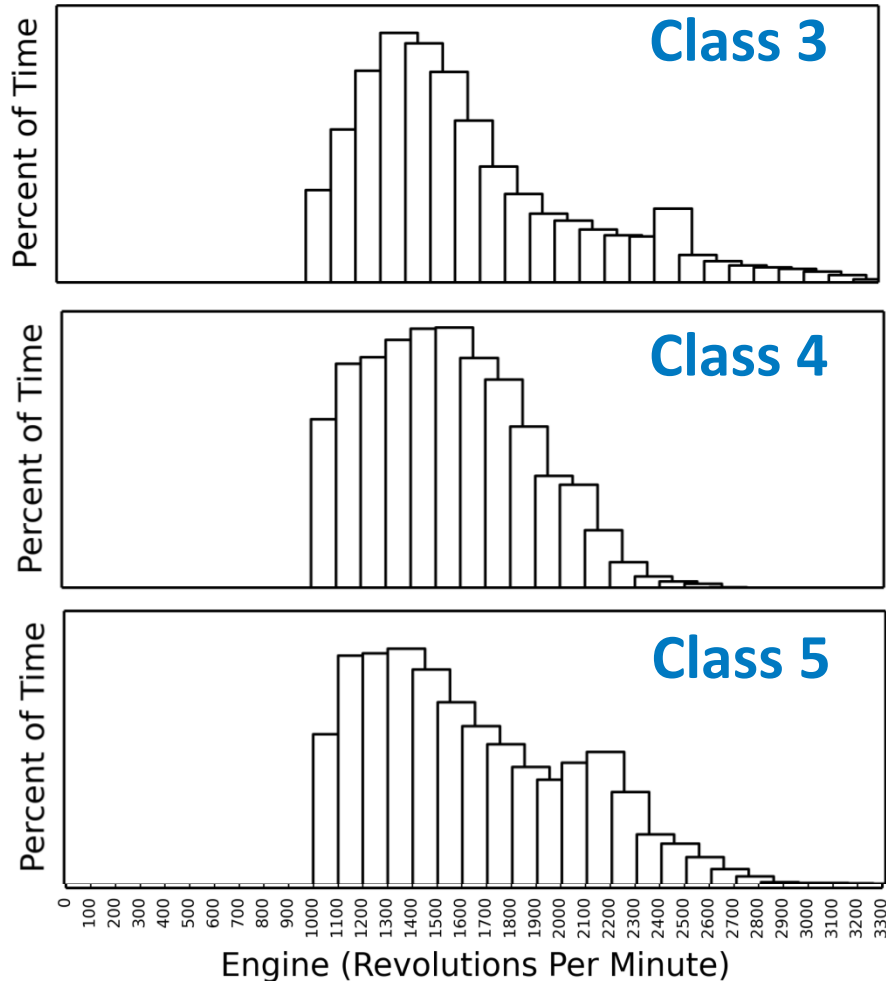
# Technical Accomplishments – Developing New Capabilities

## Analyzing Powertrain Performance

- Explore engine and powertrain relationships
  - Determine unknown vehicle characteristics from captured operating data
- Comparison engine and powertrain behavior at highway speeds across vehicle weight classes



# Technical Accomplishments – Developing New Capabilities

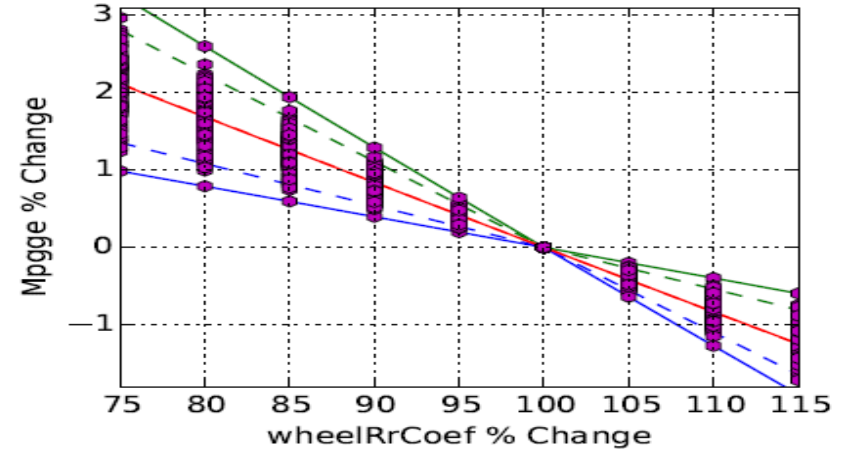
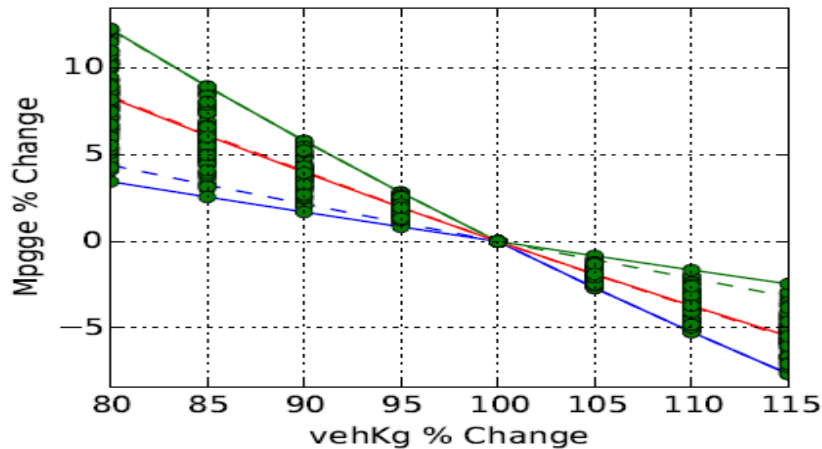
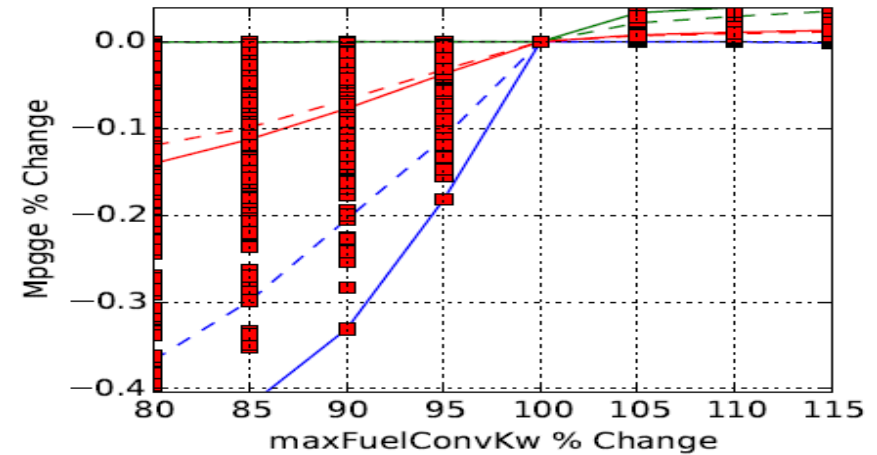
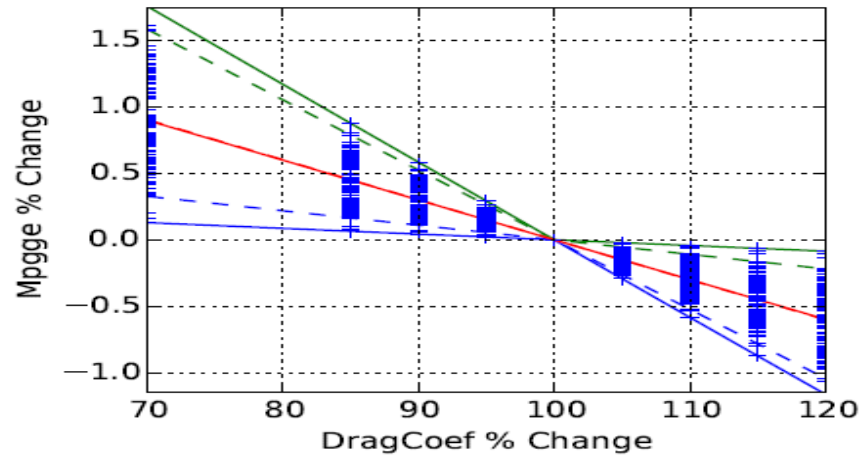


## Analyzing Engine Behavior

- Added the ability to sort and visualize engine speed data contained in Fleet DNA
  - Examine different behavior patterns based on vehicle vocation, type, or class



# Technical Accomplishments – Developing New Capabilities



## Integrated Vehicle Modeling

- Combine Fleet DNA data with integrated modeling tools to simulate fuel economy under real world conditions
  - Explore opportunities to improve fuel economy, determine lowest cost path

# Responses to Previous Year Reviewers' Comments

## Technical Accomplishments

*"The reviewer stated that the project appeared to be on schedule. The reviewer would have liked to know a little bit more about the mass estimation study (which the reviewer would call the parameter estimation study since it appears as though the PI is estimating the ABCs, and not just mass). The reviewer then asked if there are milestones involved or simply a target date of sometime in FY 2015."*

In response to the reviewer's comments, two SAE technical papers are currently in process of publication that will be documenting the work done as part of the Fleet DNA project in the areas of parameter estimation. They will be made publically available via the Fleet DNA website as soon as made available by the publisher.

## Future Research

*"The reviewer remarked that there are several key areas for proposed future work including integration of results into the Alternative Fuels Data Center, the integration of additional modeling software with the fleet DNA data base and into non-DOE tools such as EPA Motor Vehicle Emissions Simulator (MOVES). In addition, the reviewer said that the project is looking at selective cycles and vehicle type to evaluate potential for fuel cost savings over a range of technologies and fuels is planned for future work. The reviewer added that the project will be applying the fleet DNA to several other areas including helping EPA GHG Phase 2 regulations as well as SCAQMD and CARB next year. "*

Much of the focus in FY14+ for the Fleet DNA project has been the application of Fleet DNA data and tools to support additional projects both internal and external to DOE. To date, Fleet DNA has been applied as part of the EPA Green House Gas (GHG) phase 2 regulation development, to support SCAQMD and CARB in their technology evaluation and voucher incentive programs, as well as to provide an unbiased secure third-party repository of data for industry partners and fellow research institutes. Please see the additional technical slides for more details on the current applications of Fleet DNA.

## Future Research

*"The reviewer said that the data reporting and website plans appeared to be well-established, but the modeling aspect does not have the same structure. The reviewer added that the plans to bring more vehicles with known parameters into the parameter estimation study needs to be made more solid. "*

Additional work planned for the remainder of FY15 and into FY16 is focused on the development, refinement, and application of new vehicle models to be applied as part of parametric studies to explore opportunities for a wide range of fuels and technologies within the commercial vehicle market.

# Previous and Ongoing Project Collaborators/Contributors

Collaborator	Area	VT Office	Comments
ORNL	Federal Lab	Yes	Primary data collection partner working with NREL
ANL	Federal Lab	Yes	Leveraging Fleet DNA for simulation work
INL	Federal Lab	Yes	Contributing drive cycle data to database
CSU, NC State, GA Tech	University	No	Leveraging Fleet DNA data for ongoing research
Calstart	Research	No	Provided drive cycle data to Database. Leveraging Fleet DNA data for ongoing research
Clean Cities	DOE	Yes	Assisting with partner recruitment. Supplying drive cycle data to database
SCAQMD	Gov	No	Provided drive cycle data to database. Collaboration led to inclusion of Polk vehicle population dataset in Fleet DNA database.
CARB	Gov	No	Provided drive cycle data to database
EPA	Gov	No	Leveraging Fleet DNA database for regulatory work
City of Indianapolis	Gov	Yes	Provided drive cycle data and vehicle access. Applied Fleet DNA to guide fleet investment
NTEA	Industry	No	Industry project partner – Data and project partner support
GTA	Industry	No	Industry project partner – Data and project partner support
Cummins	Industry	No	Coordinating to share data analysis approach
PG&E	Industry	Yes	Providing drive cycle data and vehicle access
Waste Management	Industry	No	Provided drive cycle data and vehicle access
Verizon	Industry	Yes	Applied Fleet DNA to guide fleet investment. Provided drive cycle data and vehicle access
Many Additional Fleets	Industry	No	Provided drive cycle data and vehicle access

# New Collaborators/Contributors

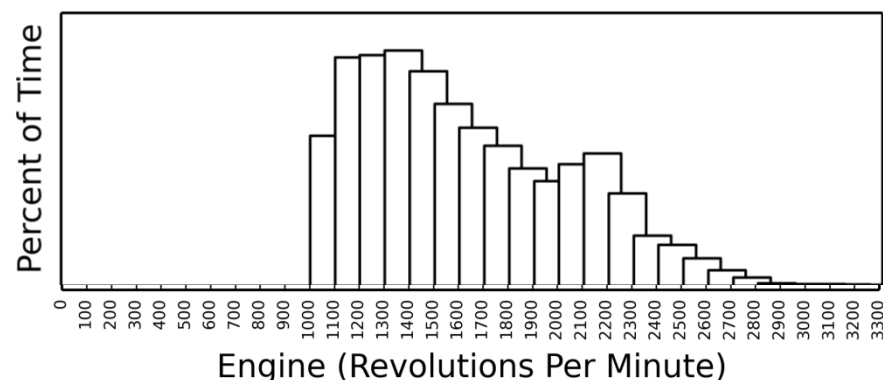
Collaborator	Area	VT Office	Comments
City of Columbus	Gov	No	Provided drive cycle data and vehicle access. Applied Fleet DNA to guide fleet investment
Miami Dade County	Gov	No	Provided drive cycle data and vehicle access. Partner for in-depth fleet technology evaluation project feeding data to Fleet DNA.
DOT/NIHTSA	Gov	No	Partner agencies leveraging data for research and regulatory work
CMU, RWTH, UMTRI	University	No	Leveraging Fleet DNA data for ongoing research
21 CTP	DOE	Yes	Applying Fleet DNA to support ongoing program objectives
EMA	Industry	No	Industry project partner – Data and project partner support
Vusion	Industry	No	Telematic provider supplying drive cycle data to Fleet DNA
Parker Hannifin	Industry	No	Providing data and analysis support
Eaton	Industry	Yes	Leveraging Fleet DNA data and capabilities for DOE funded project
Shamrock Foods	Industry	No	Provided drive cycle data and vehicle access
Zonar	Industry	No	Telematic provider supplying drive cycle data to Fleet DNA
Altec	Industry	No	Industry project partner – Data and project partner support
Navistar	Industry	No	Coordinating to share data analysis approach and develop new capabilities
Con-Way	Industry	No	Industry project partner – Data and project partner support
Blue Bird	Industry	No	Applied Fleet DNA to guide new technology research and development
CrossChasm	Industry	No	Providing data and coordinating with NREL to develop new capabilities
Frito Lay	Industry	Yes	Industry project partner – Data and project partner support
Additional Fleets	Industry	No	Provided drive cycle data and vehicle access

# Remaining Challenges and Barriers

- Data volume continues to be an ongoing challenge for the project. As Fleet DNA continues to grow, increasing “data inertia” comes into play requiring strategic planning and implementation of new capabilities, and analyses. Even with High Performance Computing (HPC) capabilities processing the large amounts of data stored within the database is no longer a trivial exercise.
- Continuing to improve external data access. Given the need to maintain existing data safeguards for anonymizing data, it is an ongoing challenge to balance making data available and usable for research activities beyond this project through publications and sharing of Fleet DNA while protecting the privacy and security of data supplying project partners.
- Ongoing integration of new datasets, data types, and the development and publication of associated data products is an ongoing project challenge requiring effective communication with project industry partners, DOE, and other labs. Understanding the needs of project end users ensures Fleet DNA continues to develop capabilities necessary to analyze new data streams and produce high value data products.

# Proposed Future Work - FY 15 Plans

- **Update Fleet DNA website with additional EV specific reports**
  - Make Navistar eStar and Smith Newton datasets available for future research
- **Update Fleet DNA website to include additional fuel economy, powertrain, and idle analyses**
  - Update reports and interactive charts and graphics
  - Add standard chassis test cycles to all reports and graphics
- **Collect additional data to further enhance the depth and breadth of Fleet DNA database**
  - Additional locations
  - More diverse technologies/fuels
    - CNG
    - Propane
    - Hybrid/electric technologies
  - Key vehicle types and vocations:
    - Class 8 Tractors
    - Class 6-7 Straight Trucks
    - Class 7-8 Transit Buses
    - Class 3-4 Service Vans
    - Class 3-6 Shuttle Buses
- **Improve controlled access portal for external users and collaborators**
  - Make process easier and more flexible to expand size of user base





# Proposed Future Work - FY 16 Plans

- **Continue to serve as secure, central data repository for field evaluations**
- **Work with new and existing partners to expand depth and breadth of database data**
- **Further enhance Fleet DNA web interface and update existing publications**
  - Visualize and select drive cycles stored in Fleet DNA
  - Bridge to medium- and heavy-duty laws and incentives information
  - Provide results of large scale simulations to help visualize which fuel/technology applications may be best suited for different drive cycle/vocation/vehicle combinations
  - New publications and reports
- **Expand Fleet DNA to store chassis dynamometer/Hardware in the Loop (HIL) fuel economy and emissions test results**
  - Work with other national labs and DOE programs to store new sharable data
- **Continue to work in partnership with ORNL/ANL/Industry/Clean Cities**
  - Apply Fleet DNA drive cycles to FastSim/Autonomie models to explore pathways for fuel economy improvements across range of vocations and vehicle types.
  - Examine opportunities for mixing technologies to achieve optimal “bang for buck” configuration based on vehicle application

# Summary

- **Fleet DNA acts as a secure data warehouse for medium- and heavy-duty vehicle data**
  - Demonstrates vehicle drive cycle data can be collected and stored for large-scale analysis and modeling applications
    - Data serve as a real world data source for model development and validation
    - Storage of the results of past/present/future data collection efforts improves analysis efficiency through pooling of shared data and provides opportunity for "big data" type analyses
- **Fleet DNA shows it is possible to develop a common database structure that can store/analyze/report on data sourced from multiple parties, each with unique data formats/types**
  - Data filtration and normalization algorithms developed for the project allow for a wide range of data types and inputs, expanding the project potential
- **Fleet DNA demonstrates the power of integrating Big Data with existing and future tools and analyses**
  - Enhanced understanding and education of users
    - Users can explore GHG and economic opportunities via AFLEET and ADOPT modeling
    - Drive cycles can be characterized and visualized using DRIVE
    - High-level vehicle modeling can be performed using real-world drive cycles via FASTSim
    - Data reporting through Fleet DNA Phase 1 and 2 websites provides external users access to analysis results and gives the opportunity to explore on their own
- **Fleet DNA demonstrates the value of storing and reapplying scientific data**

# Acknowledgements and Contacts

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**Vehicle Technologies Office - U.S. Department of Energy**

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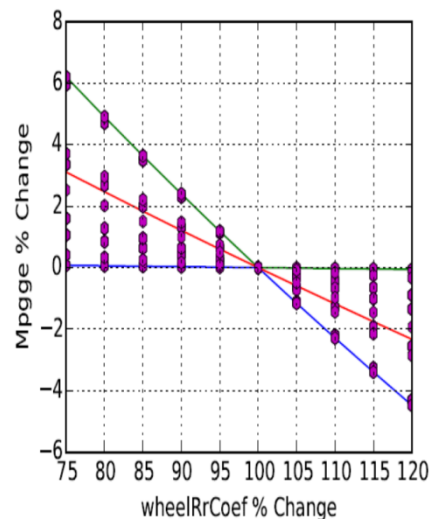
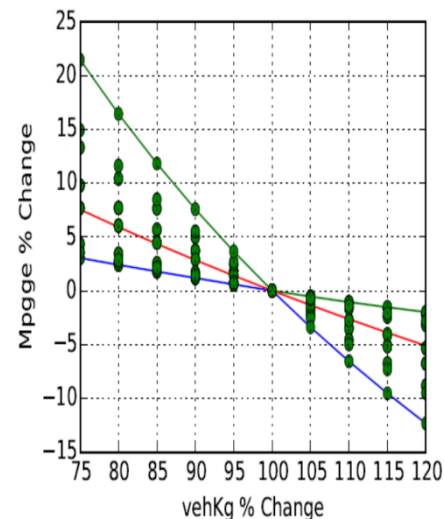
# Technical Back-Up Slides

(Note: please include this “separator” slide if you are including back-up technical slides (maximum of five). These back-up technical slides will be available for your presentation and will be included in the DVD and Web PDF files released to the public.)

# Technical Accomplishments – Applying Fleet DNA

Partnering with Clean Cities, worked with PG&E to quantify Altec ePTO system benefits for jobsite and secondary auxiliary loads

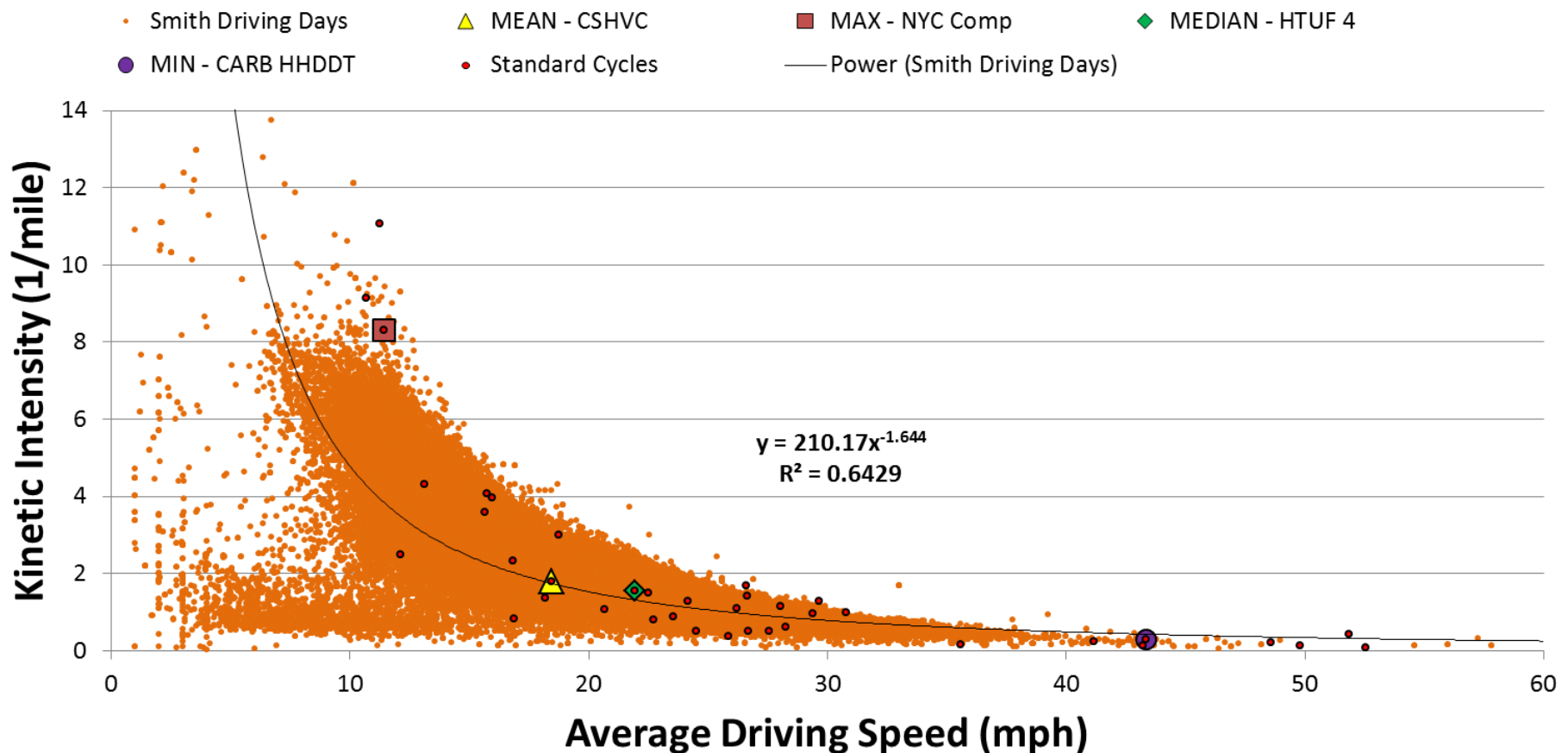
- Collected and analyze duty cycle information for trouble trucks and material handler vehicle use at a variety of locations throughout the PG&E service area.
- Met with Altec to report on jobsite operation results and received feedback from the industry perspective regarding truck placement and driver education
- Built a vehicle model using FASTSim to perform parameter sweeps to quantify vehicle performance impacts related to hybridization (e.g. additional mass, rolling resistance, aerodynamic drag)



# Technical Accomplishments – Applying Fleet DNA

Used Fleet DNA's Capabilities to Support the DOE Multispeed Commercial EV Gearbox FOA:  
Applied Fleet DNA data and tools to characterize drive cycles of typical MD EVs and compare to conventional counterparts

## Smith Newton Kinetic Intensity vs Average Moving Speed





# Technical Accomplishments – Applying Fleet DNA

## Supporting EPA Phase 2 GHG regulation development

- Applied Fleet DNA data and tools to characterize operational characteristics of vocational vehicles within the MD-HD space.
- Combining Fleet DNA data with DRIVE tool drive cycle generation to create representative drive cycles based on real world vehicle usage

